

## CYCLONES AND SUGAR-CANES.

*The Sugar Industry of Mauritius: a Study in Correlation. Including a Scheme of Insurance of the Cane Crop against damage caused by Cyclones.*

By A. Walter. Pp. xvi+228. (London: A. L. Humphreys, 1910.) Price 12s. 6d. net.

**M** AURITIUS, situated just within the tropics and on an edge of the southern anticyclonic system, is in certain circumstances visited by tropical cyclones. Occasionally great damage to the growing sugar crops is done by such visitations, and though extremely violent storms are exceptional, yet the fact that they may and do occur makes the cyclone season one of dread and anxiety in the island. In the year 1892, for example, about one-half of the total crop was destroyed, to say nothing of damage to buildings, and other losses. True, this storm was one of quite unusual severity; but fear of a similar calamity tends, nevertheless, to have a paralysing effect upon the sugar industry. "Behind every attempt at improvements and every fresh outlay of capital, hovers the spectre of the 1892 disaster."

In these circumstances the question of insurance becomes one of primary importance. With a view to obtaining some rational basis for proposals of insurance the investigation described in the volume before us was undertaken: it is an attempt to determine quantitatively the relative effects of rainfall, temperature, and cyclonic wind-velocity upon the amount of the sugar-crop.

Obviously the problem is a complicated one. The author attacks it by a study of the climatic statistics for a number of years, in correlation with the crop harvested in each of those years. By successive approximations, after allowing for exceptional influences, it has been found possible to evaluate the effects of the several climatic factors upon the crop.

Taking first the question of rain, the changes in the amount of crop were found to follow in a general sense those of the rainfall, but the ratio *crop/rainfall* varied considerably from year to year. There is, however, not merely the total quantity of rain to be considered; the number of rainy days was soon seen to be as important as the total rainfall. From an agricultural point of view a month in which five inches of rainfall was distributed over twenty days would be a wetter month than if the whole had fallen in one day. Hence in order to obtain the combined effect of quantity and chronological distribution, the idea of "degree of wetness" for each month was introduced by means of the expression  $R.t^1/t$ , where  $R$  is the total rainfall for the month,  $t$  the number of days, and  $t^1$  the number of rainy days. But further, in excessive falls a part of the rain is non-effective, and it was necessary to eliminate this portion, partially at least. The method adopted depended upon the consideration that if it were possible to determine the depth of soil to which a given fall penetrated, the amount which passed beyond the limit of the cane roots might be rejected. Increase of temperature in the soil at certain depths was taken as a guide to the points beyond which the fall penetrated.

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The effect of high wind velocity on the cane is regarded as falling under one or all of the following heads:—(a) Tearing of the leaves; (b) bending of the stem about its weakest part; and (c) loosening and rupture of the roots. The magnitude of the effect (a) depends upon the pressure  $P$  of the wind, the duration  $h$  of the high velocity, and the epoch  $t$  in the plant's growth at which it occurs, since the riper the cane the greater the damage; effects (b) and (c) depend also on the amount of change  $\theta$  in the direction of the wind, the greatest damage being caused when the cane is bent in directions differing by  $180^\circ$ . Whence the total effect on the crop is deduced to be expressible by the formula  $\kappa P^2 h (2 + \sin \frac{1}{2} \theta) \sin \frac{1}{2} t$ . The value of the constant  $\kappa$  is obtained from the crop results given in three cyclone years, after eliminating the rainfall and temperature effects. This formula is suggested as a basis for determining the loss due to a cyclone, the values of  $P$ ,  $h$ , and  $\theta$  being taken from the official observatory records. The practical application for purposes of insurance is explained in detail.

The work is an ingenious and interesting statistical study which may prove to have practical value. A prediction of the crop yield for 1908, based on the methods explained, turned out to be correct within 3 per cent. There seems no reason why, if circumstances demanded it, the methods should not be applicable to other crops than sugar.

C. S.

## IRRIGATION ON THE INDUS.

*Punjab Rivers and Works.* By E. S. Bellasis. Pp. vii+65+47 figs. (Allahabad: printed at the Pioneer Press, 1911.)

**T**HE author presents this work as a treatise setting forth the general rules and principles on which the inundation canals and flood embankments of the Punjab are designed and maintained, since no such work has hitherto existed. This we may take as equivalent to saying that the regulations and practice of the Punjab Irrigation Service have not yet been systematised and brought into book form, since the present volume deals with this aspect of the subject, and does not, unfortunately, cover the wider field of the hydrography of the Indus in its bearing on the utilisation of its water.

While the first chapter deals very briefly with the rivers of the Punjab and their physical characteristics, the next three discuss in considerable detail the inundation or flood canals, the flood embankments, and the river-training works; the last chapter and seven appendices deal with the ordinary procedure, and give certain regulations, orders, and specifications as issued for the work of the Service. The information relating to canals deals with their maintenance, silt deposit, erosion, their section, alignment, and the various modifications which have to be adopted in dealing with the water of a river which has a high seasonal flood and carries a heavy silt load. These characteristics also necessitate flood embankments to control the

river flood and protect certain areas in time of the inundation; while no less important are the river-training works to restrict the erosive action of the river on its banks at points where it may damage existing distributing works and towns or villages.

The information so brought together should be of much interest to irrigation engineers, and would have been valuable to a wider circle if fuller material had been provided for those not personally conversant with the Punjab. The case of the gradual destruction of the town of Dera Ghazi Khan on the west bank of the Indus by the gradual erosion of its right bank furnishes an interesting case of river action by the annual flood, and is illustrated by a series of ten plans showing the disposition of the river at this point from 1882 to the present time.

Elsewhere general statements and descriptions are in the majority, and we should have welcomed more quantitative treatment of some of the interesting points which are raised. The regimen of a part of a river cannot be properly understood without some knowledge of the whole, and the lack of this is especially apparent in the first chapter, where a general map of the basin, some information regarding its size, form, relief, structure, &c., would have given a valuable setting to the study of the utilisation of its water which follows. The subjects of rainfall and discharge are dealt with in two brief paragraphs, while we look in vain for maps showing the distribution of the rainfall or diagrams explaining the variations of discharge at different points and at different seasons. A number of plans and diagrams illustrate the report, but in only one case is the scale of the former indicated on it, though in some other cases it can be found from the text. References to other works on the Indus would have been a useful addition. H. G. L.

#### ELEMENTARY STATISTICS.

*An Introduction to the Theory of Statistics.* By G. Udny Yule. Pp. xiii+376. (London: C. Griffin and Co., Ltd., 1911.) Price 10s. 6d. net.

OF all the works a man may set himself to write, the most difficult must surely be an elementary text-book on statistics. The writer of a text-book on almost any scientific subject has to face the difficulties resulting from a recent rapid development of the science of which he is writing, but in statistics he has the further difficulty that many practical methods have been reached by mathematical analysis that is unsuitable for an elementary text-book. Nor is this all, for the subject appeals to so many diverse interests that points simple or useful to one student are merely troublesome or inconsequent to another.

Mr. Yule has made an attempt to explain some of the methods used in practice, without demanding much mathematical knowledge of his readers. This course explains the advantages as well as the limitations of his work, for it has enabled him on one hand to display his natural facility of explanation, and, on the other, it has debarred him from giving more than a sketch of some of the most important parts of the subject; it has even led him to avoid

giving certain formulæ and methods that are of almost everyday use.

The book is divided into three parts, the first of which deals with the theory of attributes. We confess that this type of statistical work does not greatly appeal to us, for while good may be done with these methods by a statistician of Mr. Yule's ability, we are doubtful if the notation and formulæ he gives are of real help to a student. To most minds statistical errors in reasoning, for instance, are best explained arithmetically, and many of Mr. Yule's examples in part i. will help his readers more than his algebra or letterpress. The second part deals with the theory of variables, "ideal frequency distributions," averages, standard deviations, and correlation coefficients. There is a chapter on partial correlation which should be helpful to many readers, but we wish room had also been found for an account of some of the most recently discovered methods of calculating correlation coefficients. The last part of the book deals with the theory of sampling, and is mainly concerned with probable errors.

Possibly because of the mathematical work involved, Mr. Yule does not deal with the fitting of curves to statistical data, but a student who has proceeded so far as to study partial correlations and the correlation surface should, we think, have some idea how to do this. The gap will perhaps be filled in a future edition, and revision in some other respects will, we think, also be wanted. For instance, on p. 38 a formula is given for measuring the degree of association, and if it is applied to the example of imbecility and deaf-mutism on p. 34, the value is 0.9, indicating a high degree of association. On p. 213, instead of giving the ordinary formula for working out coefficients of correlation from fourfold tables, Mr. Yule gives a simple expression which he implies can be used in some cases. Unfortunately, in the particular case mentioned above to which a student might be tempted to apply it, the value, instead of being about 0.9, is only 0.02, and gives quite a wrong impression. It was, we think, a great mistake to give the formula on p. 213, as it is open to considerable criticism.

Another example of a case where readers might be misled occurs on p. 67, where a student might easily misunderstand Mr. Yule's discussion of isotropic distributions, and think that they affected the calculation of a coefficient of contingency.

While we are very ready to admit that, within the limitations he has placed on himself, Mr. Yule has given much that is of interest and value, we also feel that there is much in his work which lends itself to criticism—more, in fact, than one would expect to see in an elementary text-book. The two cases that we have given above are merely examples of this, but although we have felt it necessary to criticise, it is a pleasure to add that we have been much interested in reading Mr. Yule's work, and have throughout appreciated his numerous arithmetical examples and the trouble that must have been taken to arrange the book in so clear a form and to supply it with such excellent diagrams.